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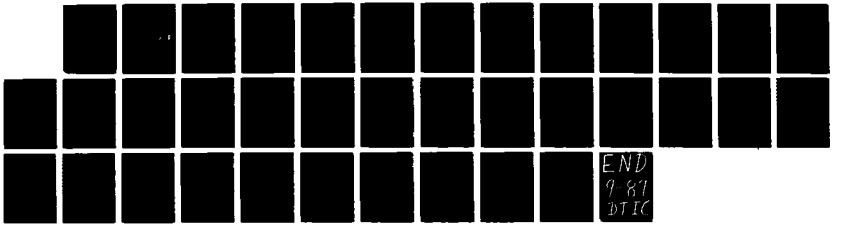

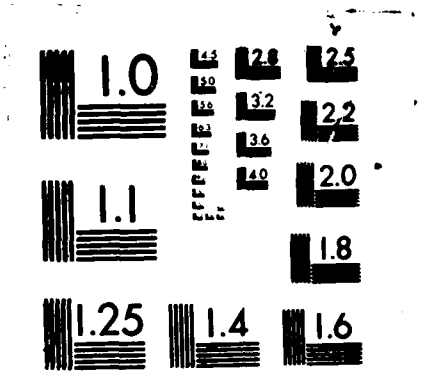

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NKF Report No.
87103-003/03

FIBER OPTIC ENGINEERING SENSOR SYSTEM

PRELIMINARY

PROGRAM MANAGEMENT PLAN

PHASE III REVISION

AD-A183 663

PREPARED IN RESPONSE TO:

CONTRACT NO. N00014-87-C-2032

PRESENTED TO:

FIBER OPTICS TECHNOLOGY PROGRAM OFFICE
NAVAL RESEARCH LABORATORY
WASHINGTON, DC 20375-5000

PRESENTED BY:

NKF ENGINEERING, INC.
12200 SUNRISE VALLEY DRIVE
RESTON, VIRGINIA 22091

JULY 1987

NKF Report No.
87103-003/03

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to outline operating procedures and responsibilities of participants in Contract No. N00014-87-C-2032 between the Naval Research Laboratory (NRL) and NKF Engineering, Inc. (NKF), the prime contractor and to describe NKF's plans for accomplishment and management of this effort.

NKF, with corporate headquarters located at 12200 Sunrise Valley Drive, Reston, Virginia 22091 is the prime contractor for this contract. The Program Office for this effort is located at NKF's Washington Branch Office at One Crystal Park, Suite 1100, 2011 Crystal Drive, Arlington, Virginia 22202. The managerial and engineering services required for contract performance will be provided through key personnel of NKF and its subcontractor, Applied Remote Technology, Inc. (ART), whose office is located at 9950 Scripps Lake Drive, Suite 104, San Diego, California 92131.

1.2 BACKGROUND

The principal objective of this program is to develop a Fiber Optic Engineering Sensor System (FOESS) including sensors, telemetry, and displays for applications such as damage control, system control (i.e., propulsion or steering) and intrusion defense systems for ship, aircraft and shore applications. This objective is being achieved by research and engineering effort conducted in three, originally four, contractually defined phases.

NRL issued a competitive solicitation on 19 May 1986 for professional engineering and technical services required to undertake this effort. In response to this solicitation, NKF and its subcontractor, Applied Remote Technology, Inc. (ART), submitted a proposal on 27 June 1986.On 31 December 1986, following the source selection process, NKF was awarded Contract No. N00014-87-C-2032 for Phase I and II of the program.

The objective of Phase I was to develop a concept design of a FOESS. NKF achieved this and presented the results in NKF Report No. 87103-001/13 (Concept Design Review Data Package) of 29 April 1987. The objective of Phase II was to develop a laboratory demonstration model, by implementation of the design approved at the Phase I System Design Review. Phase II activity was terminated shortly after it had begun; only some preliminary concept design verification had been achieved and some preliminary results were recorded at this stage. NRL amended the program schedule, effectively combining Phases II and III, and awarded a NKF portion of the revised Phase III. Accordingly, during the period of the Contract NKF shall provide professional engineering and technical services as required by the revised Contract Statement of Work (SOW), reproduced for convenience at Appendix A.

2.0 PROGRAM OBJECTIVES

The objectives of Phases III and IV are described as follows.

2.1 PHASE III - ADVANCED DEVELOPMENT MODEL (ADM)

The technical objectives of Phase III are to design, develop, fabricate, test, demonstrate, and deliver prototype Advanced Development Modules (ADM) of each of the following types of sensors:

- o Pressure 0 to 100 psig
- o Differential pressure 0 to 100 psi
- o Temperature 0 to 400°F
- o Linear displacement 0 to 1 inch

and the minimum associated electro-optical package.

2.2 PHASE IV - ENGINEERING DEVELOPMENT MODEL (EDM)

The EDM will be the implementation of the design approved following the Critical Design Review held in Phase III, in a configuration which will comply with form, fit, and function requirements for shipboard use. It will have functional and physical interface compatibility with the damage control, propulsion control or other ship's equipment interface for the sensor signals for the type of sensor system under development. The EDM will be tested in accordance with the test plan and procedures approved by NRL for Phase IV and meet all requirements for laboratory and shipboard tests. After design, fabrication, and test it will be delivered to a naval platform in a deployable, though not yet military qualified, configuration. It will then be installed and tested and appropriate documentation and logistical support will be provided.

3.0 PHASE III - ADVANCED DEVELOPMENT MODEL METHODOLOGY

The Team will achieve the objectives of Phase III of the contract in three parts: Design, Fabrication, and Test and Evaluation, as described below. The activities involved are shown in the Work Breakdown Structure (WBS) (Appendix B) and their schedules are shown in the Phase III Milestone Chart (Appendix C). Each of the ADMs will be designed and fabricated in parallel with the others using standard interface specifications.

3.1 DESIGN PHASE

3.1.1 Electro-optical Module

This effort will be limited to only the essentials required for validating and testing of the Transducer/Conversion module sensor design. Laboratory experiments and simulation will be used to provide indications of sensor performance degradation due to other than transducer characteristics. An example of these concerns is back scatter caused by connectors.

3.1.2 Transducer

The universal fiberoptic transducer design will be the maturing of Phase I concept, originally presented as the HAML. The design will be based upon results of validation testing in the shortened Phase II. As the final design and drawings are being prepared for the design review package, laboratory testing will be performed to provide risk reduction through design validation.

3.1.3 Conversion Modules

This portion of the design is dependent on the interface design specifications of the transducer. After this interface has been defined, only the mechanical engineering to provide the sufficiently accurate modules remains. Latest engineering practices will be used to design the modules to the specification goals. Present plans call for the Team's San Diego based group (ART) to design the prototype ADM Electro-Optic Module and Universal Transducer. The four prototype ADM conversion modules will be designed as follows:

- o ART will design the Displacement, Pressure and Differential Pressure modules;
- o NKF personnel in Crystal City will design the Temperature and alternate Pressure and Differential Pressure modules.

This approach is advantageous since it will:

- o Facilitate timely completion of the designs;

- o Increase the probability that four successful designs will result with this accelerated schedule;

- o Using interface design specifications, demonstrate that additional modules can be independently designed for use with a standard universal transducer.

3.2 FABRICATION PHASE

Fabrication of the prototype electro-optical module, universal fiberoptic transducer and one of each of the four conversion modules (temperature, pressure, differential pressure, linear displacement), will take place during this part of the first portion of Phase III. Exact fabrication processes to be used cannot yet be described since the design is not complete at this writing.

3.3 TEST AND EVALUATION PHASE

3.3.1 Initial Tests

All initial testing of components, sub-assemblies and assemblies will be conducted during the fabrication phase, in house at ART's San Diego facility.

3.3.2 Environmental testing

Present planning is for these tests to be conducted at an environmental testing facility operated by Teledyne Ryan in San Diego, Ca.

3.4 MATERIAL

Military qualified parts will be used to the maximum extent possible and the best standard industrial packaging practices will be employed.

4.0 PROGRAM MANAGEMENT

4.1 PROJECT CONTROL SYSTEM

A project control system has been activated for the performance of the FOESS Phase III effort which will provide for timely recognition of and reaction to the three types of challenge (technical, schedule and financial) that may arise. The system will generate the information needed to ensure the technical excellence of all work performed and deliverables submitted, that effort is correctly assigned on or before schedule, and that work is completed in the most resource-efficient manner possible within specified man-hour and cost constraints.

The system, which is described more fully below, is derived from that used by NKF for all contract effort and will be employed by NKF throughout the FOESS program.

4.1.1 Technical Control

The NKF Program Manager will maintain close liaison with NRL to provide clear visibility of task progress and to identify any perceived or anticipated technical problems. Complete documentation of NKF's technical efforts, significant accomplishments, results, and problem areas will be provided in the technical section of the monthly progress report for ongoing work; these reports will be prepared by the Program Office and approved by the Program Manager.

In NKF's FOESS contract activity, in-house technical reviews of work efforts will be conducted to ensure management visibility, as well as formal technical reviews for clients. The frequency of such reviews will be governed by the scope and intensity of the work. Given the technological challenge and schedule constraints of the FOESS task, NKF has established an Executive Review Panel of senior management and technical specialists who will be available to assist the Program Manager in review and reading technical management issues of particular criticality.

All task deliverables will be prepared under the direct supervision of the Program Manager. Also, all contract deliverables will be reviewed by NKF's Deliverable Quality Assurance Controller to ensure they conform to a suitable quality standard for submittal to NRL.

4.1.2 Schedule Control

Close control will be exercised so that schedule impacts associated with technical problems are readily identified and resolved as they arise.

4.1.3 Financial Control

Financial records (man-hours and dollars) for all work are maintained by NKF's corporate administrative staff, utilizing a computer-based cost

control system. As for every contract undertaken by NKF, the FOESS contract has been assigned a unique NKF job number to permit separate tracking. The financial records for all ongoing work will be updated weekly. The reports will contain cumulative expenditures of man-hours, direct labor dollars, and other direct costs (e.g., travel, computer usage, etc.); the remaining man-hours, direct labor dollars, and other direct cost budget; cumulative man-hour and dollar expenditures as percentages of authorized ceiling values for the task; and a comparison of budgeted, actual, and remainder-to-completion average labor rates. Financial problems will be recognizable immediately if actual expenditures tend to depart from planned/budget values. This will enable the NKF Program Manager to take corrective measures in a timely manner.

4.1.4 Management Information System

NKF will implement a management information system to support the overall program, including subcontractor activities. This system has been designed to facilitate efficient communications as follows:

- Systematic and ad hoc reporting on program status to NRL by NKF as Prime Contractor.
- Prompt internal reporting of program activities.
- Electronic data exchange with ART and electronic mail exchange with NRL and ART.

4.2 PROGRAM OFFICE

NKF has assigned John T. Jenkins as Program Manager to head a team of key personnel. He will act as the counterpart to NRL's COTR to ensure that all aspects of NKF's performance in this contract, including all cost, technical and schedule control, are in accordance with the provisions of the contract and with NRL directives. In accordance with NRL directives, NKF has given the Program Manager full access to all corporate resources and support personnel that may be required for the successful performance of this contract effort. The Program Manager is fully responsible for contract performance to John J. Turner, NKF Senior Vice President, and will report directly to him.

Other key personnel assigned to support the Program Manager, with responsibility for providing all necessary engineering and technical services required by the contract, include Charles S. Slemon (ART), Design Engineer and Richard E. Buteux (NKF), System Engineer.

TABLE 1 summarizes individuals' responsibilities and FIGURE 1 depicts the lines of control of the organization established in support of this contract.

TABLE 1 - KEY CONTRACTOR PARTICIPANTS AND RESPONSIBILITIES

NKF

J. J. Turner	Senior Vice President	Line organization support to NKF Fiber Optic Engineering Sensor System Program Office. Point of contact for NRL liaison with NKF Corporate Management.
J. T. Jenkins	Program Manager	Program direction, supervision of all program efforts, point of contact for liaison with NRL.
R. E. Buteux	System Engineer	Technical support to the Phase I Existing Sensor evaluation and trade-off analysis. Responsible in later Phases for coordination of T&E Programs, operations of maintenance instructions, ILS, CM and R&M.
S. Feldman	Quality Assurance Controller	Review of all contract deliverables to ensure compliance with contract requirements and technical excellence.
J. W. Maslin	Vice President Finance	Corporate Financial control.
K. Williams-Miller	Contract Administrator	Contract Administration.
R. D. Liptrap	Security Officer	Coordination of security requirements.

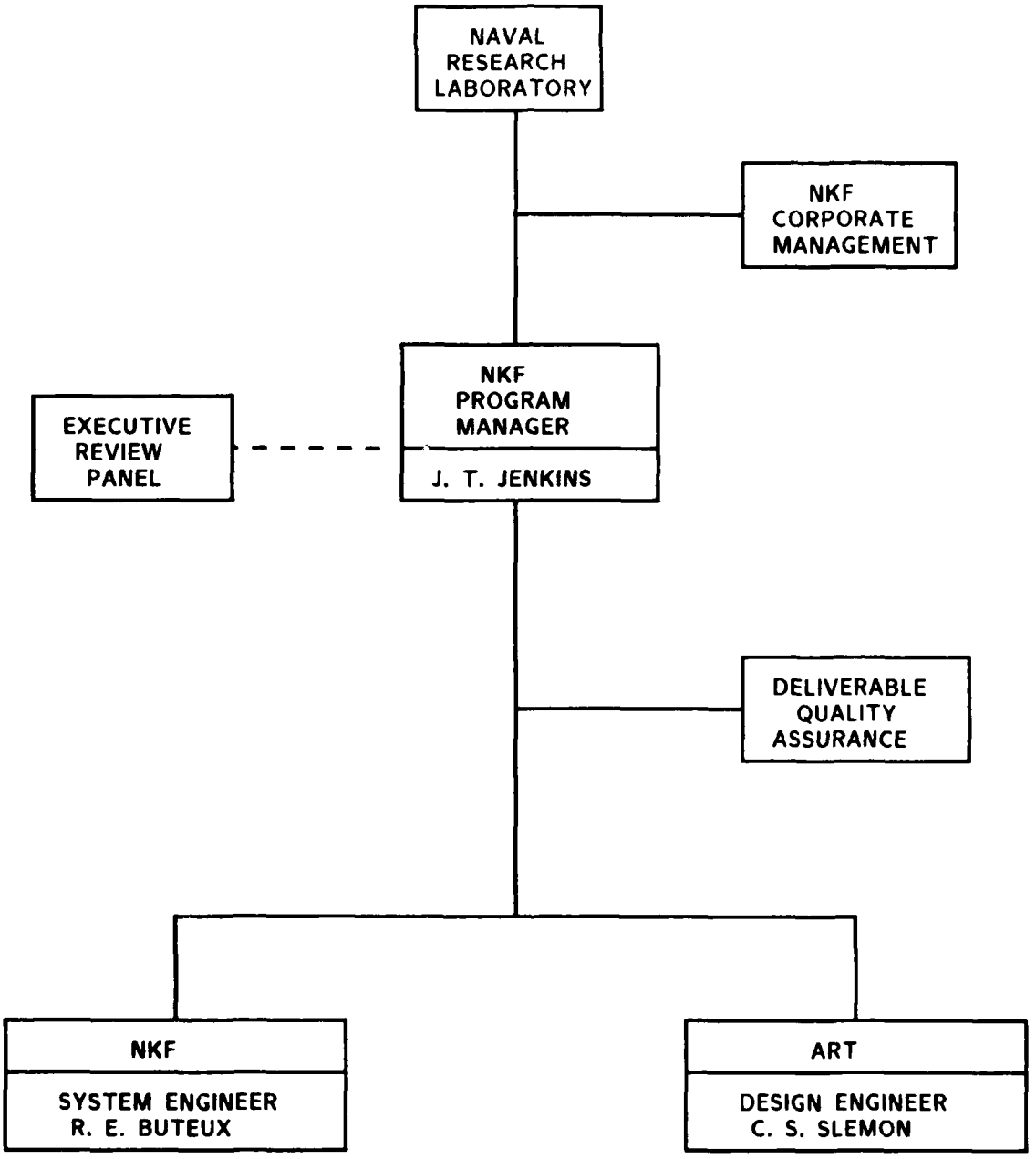
ART

C. S. Slemon	Design Engineer	Design engineering of the Fiber Optic Engineering Service System and development of Phases II, III and IV Models.
D. A. Neuschuler	Test/Logistics Designer	Development and application of test procedures and support ILSP and Maintainability Phase.
W. M. Lafferty	Assistant Design Engineer	

NKF/ART Executive Review Panel

J.J. Turner	NKF	Technical guidance in critical issue resolution.
J.W. Abbott	NKF	
R. Walrod	ART	
T.E. Diamond	ART	

FIGURE 1 - CONTRACTOR LINES OF CONTROL



4.3 KEY GOVERNMENT CONTRACT PARTICIPANTS

4.3.1 Contracting Officer

The NRL Contracting Officer for this contract is John H. Ablard, Code 1230. His office is in Room 130 of NRL Building 222, telephone (202)767-5227.

4.3.2 Contracts Specialist

The Contracts Specialist for this contract is Vickie Chesley, Code 1232.VC. Her office is in Room 115 of NRL Building 222, telephone (202)767-2021.

4.3.3 Contracting Officer's Technical Representative (COTR)

The Contracting Officer's Technical Representative for this contract is John E. Donovan, Code 6503.1, Head of Fiber Optics Technology Program Office. His office is located in Room 208 of NRL Building 1, telephone (202)767-2174.

4.3.4 Contract Monitor

The Contract Monitor for this contract is Carl Villareul, Code 6570. His office is located in Room 115 of NRL Building 222, telephone (202)767-2021.

4.3.5 Other Contracting Officer's Assistants

The Contracting Officer's Security Specialist for this contract is NRL Code 1221, telephone (202)767-2240.

The Contracting Officer's representative for Inspection and Acceptance for this contract, including invoicing, is Code 1235, telephone (202)767-3782.

Patent matters will be referred to Dr. Sal Sheinbein, Code 2004, telephone (202)767-3437.

4.4 NKF/GOVERNMENT INTERFACES

4.4.1 Communications

Effective communications between key participants in the contract are necessary to ensure timely response to the Navy's needs. Inherently, the requirement is to keep all parties informed, avoid surprises for senior management personnel and to head off potential problems or controversies before they can develop. The NKF Program Manager will keep the COTR informed of significant developments on a regular basis. In turn, the COTR will relay instructions and administrative and coordination requirements to the NKF team through the NKF Program Manager.

The Rapicom 120 Facsimile Transfer unit and the NKF VAX 11/780 computer using MASS-11 software compatible to NRL and ART's equipment, will both be used for the transfer of mail and other documents. Transfers will be initiated during evenings where practical to effect economy in telephone costs.

While telephonic and other forms of oral communications are appropriate in some situations, primary emphasis will be placed on written communication. Discipline is required in this regard and the Navy Correspondence Manual (SECNAVINST 5216.5C dated 24 August 1983) will be used by NKF as a guide to simple yet efficient writing styles.

A Telecon report form will be completed by contractor personnel as a record of all telephone discussions between key participants relating to technical matters concerning this contract.

4.4.2 Progress Review Meetings

NKF will hold monthly progress review meetings with the COTR (see Schedule, Appendix C), and will present the following items of information:

- o Status of all Key Program Elements
- o Near and Mid-term Objectives for Upcoming Period
- o Action Items
- o Areas of Concern
- o Recommendations.

4.5 REPORTS

The deliverable products required by the first portion of the FOESS Phase III effort to be undertaken by NKF are listed as follows:

- o Progress Reports
- o Monthly Cost Reports
- o Design Review Data Package
- o Drawings
- o Test and Evaluation Plan

These are specified in the Contract Deliverables Requirements List and are shown in the Milestone Schedule (Appendix C).

4.5.1 Report Preparation and Content

All reports will be prepared in conformance with the format requirements contained in the Data Item Description referenced by the CDRL. Where format is not specified, reports will be prepared in accordance with the NKF Technical Instruction on "Standard Format of NKF Technical Reports" dated 16 December 1985. In summary, the content of each report will be as follows:

- o Progress Reports. These will be provided monthly by letter and will include a section specifically addressing schedule and status, as well as sections outlining work accomplished and planned for each reporting period; interim and preliminary design results and conclusions; problems or delays encountered or anticipated; and proposed solutions to any potential problem areas. These reports will provide regular opportunities for all interested parties to detect schedule problems and initiate corrective action. The detection of schedule problems will be facilitated by comparing actual accomplishments and the planned

schedule developed at the beginning of the work and by comparing the technical effort performed each month (as documented in the Monthly Progress Reports) with the work planned for that period. Four such monthly reports will be provided during the Phase III timeframe.

- o Monthly Cost Reports. These reports, of which there shall be four during the Phase III timeframe, will include indication of all labor expenditures (reflecting person, hours worked, cost); materials (description, cost and use on contract); and travel (traveler, date of travel, reason for trip and cost).

- o Drawings. These will be blueline prints in the format selected by the NKF Team, designed to meet Level 1 requirements of DOD-D-1000B and amendment dated 13 May 1983.

- o Design Review Data Package. This will include plans, procedures, drawings, specifications and the results of analyses and tests applicable to the FOESS Phase III effort.

- o Test and Evaluation Program Plan. A test plan will be provided for NRL approval for the environment and acceptance tests to be performed on the ADMs. Separate test procedures will be prepared for each type of ADM covering each test to be performed.

4.5.2 Reports Review

The principle of complete staff action shall govern NKF's conduct of business with NRL. All reports, whether for preliminary review or final issue, will be subjected to a comprehensive NKF review. NKF will use a deliverable tracking system to assure the timeliness of all scheduled product deliveries. When extensive and formalized review of NKF technical reports by NRL is directed by the COTR, a three-stage review cycle is intended. In summary, the process consists of the Preliminary Draft Review Stage, the Adjudication Stage and the Final Draft Review Stage, as follows:

- o Preliminary Draft Review

  NKF submits first draft to COTR
  COTR checks draft's suitability for Preliminary Draft Review.
  COTR notifies NKF of number of draft copies required and arranges schedule for review by NRL personnel.

- o Adjudication

  Review comments are consolidated.
  An adjudication meeting, attended by COTR, NKF and relevant reviewers, determines which review comments should form revisions to the first draft.
  Agreed revisions are entered into the draft to form the "Master Mark-up."

Written adjudication minutes reflecting accepted comments are passed to NKF and COTR. These minutes will, in many cases, refer to the "Master Mark-up."
Upon COTR's approval of the minutes, NKF revises the draft document, incorporating all specified comments and resubmits the product for the next stage of review.

- o Final Draft Review

  COTR verifies the corrected draft document against the Adjudication minutes and "Master Mark-up."
  COTR, once satisfied with the document, notifies NKF to proceed with submission of the final deliverable, indicating the appropriate number of copies required.

4.5.3 Reports Submittal

Government acceptance of contract deliverables is signified by COTR signature of FORM DD250.

4.6 ADMINISTRATION

The following gives details of some administrative procedures governing the performance of the contract work.

4.6.1 Contracting Officer

Any change to the provisions of the contract must be approved by the Contracting Officer.

4.6.2 Contract Files

NKF will maintain an individual file jacket for each phase, maintaining a complete file which contains the following:

- o Statement of work
- o Draft and final deliverables
- o DD 250's
- o Other pertinent information

The NKF Program Manager will also maintain a complete file of COTR meeting reports, DD 254's, travel clearances and visit requests. These files will be maintained such that they are always available for audit.

4.6.3 Personal Services

The NKF Program Manager and the COTR will ensure that the performance of this contract does not involve personal services.

Federal Acquisition Regulations define "personal services contracting" as the procuring of services by contract in such a manner that the contractor or his employees are in effect employees of the government. Except as authorized

by express statutory authority, the Civil Service laws and regulations and the Classification Act are not to be circumscribed through the medium of "personal services contracting." To do so is illegal.

4.6.4 On-site personnel

NKF personnel will not conduct on-site work exceeding 10 hours per week unless expressly approved by NRL in accordance with existing directives.

4.6.5 Security

All activity under this contract shall conform to the requirements of the Contract Security Classification Specification (DD 254) and the Industrial Security Manual for safeguarding classified information, DOD 5220.22M, dated March 1984.

In the preparation of technical reports, NKF and subcontractor personnel shall be guided by the DD Form 254 attachments and supplements, as appropriate, to provide classification specifications. Originators (authors) of reports will be cautioned to be mindful of the impact on classification resulting from combining separate elements of information in the report.

NKF is aware of the necessity for vigilance against inadvertently disclosing NRL technology.

4.6.6 Use of Contractor Facilities

NKF team conference rooms are available for use by NRL personnel in connection with meetings required for work assigned under the contract.

4.6.7 Travel

The COTR shall be advised during the monthly COTR reviews of all non-local travel required by the NKF team under the contract.

All foreign travel shall be approved in writing by the COTR prior to its commencement.

4.6.8 Procurement of Equipment

The contract provides for no Government furnished equipment. Thus, all procurements to support this contract must be funded by contract monies.

4.7 SUBCONTRACTING

A subcontract for elements of this effort has been established with Applied Remote Technology, Inc. (ART). Comprehensive integrated liaison procedures have been established to govern the interrelationship between NKF and ART.

Deliverables produced by ART under this contract will be delivered under the supervision and management control of the NKF Program Manager. No deliverable products will be submitted to NRL by ART. All contract products, including those suggested by ART, will be submitted to the government by NKF following the review procedures already discussed. All contractual liaison with NRL will be made by the NKF personnel described earlier. ART's cost and technical progress will be reported to the government as an integrated element of NKF's Monthly Report.

5.0 OVERALL ASSURANCE

The NKF team recognizes that the objectives of all Phases will be met by the delivery to NRL of all data, designs and models of the highest quality commensurate with the stipulations of the contract and the directions of NRL. The team intends to achieve this in Phase III, and Phase IV, achieving successful completion of the work, on schedule and within budgetary limits, by application of their proven management and technical expertise.

Appendix A

FOESS

CONTRACT STATEMENT OF WORK

STATEMENT OF WORK (SOW)
FOR A
FIBER OPTIC ENGINEERING SENSOR SYSTEM

1.0 SCOPE

The Naval Sea Systems Command (NAVSEA) has initiated a program at the Naval Research Laboratory (NRL) Fiber Optics Technology Program Office to develop and demonstrate fiber optic sensor systems in a wide range of naval engineering applications. The principal objective of this program is to develop fiber optic engineering sensors including telemetry for applications such as damage control, systems control(i.e., propulsion or steering) and intrusion defense systems for ship, aircraft, and shore applications. The near term thrust of the program is to demonstrate a system capability (including telemetry) for the measurement of a multitude of physical parameters such as fluid flow, fluid pressure, mechanical strain, electromagnetic fields, temperature, air quality, specific gravity, and liquid level.

This statement of work covers the work and program requirements for a four phased effort to install a fiber optic engineering sensor system engineering demonstration model (EDM) on a naval platform to demonstrate the advantages of fiber optics in naval applications.

EDMs for one or more different engineering sensor systems, i.e., damage control, propulsion control, or environmental control systems will be developed.

2.0 APPLICABLE DOCUMENTS

The following documents of the issue in effect on the date of the request for proposal form a part of the statement of work to the extent specified herein.

2.1 MILITARY SPECIFICATIONS

DOD-D-10008 Engineering Drawings and Associated Lists

MIL-C-2212F	Controller, Electric Motor, AC or DC, and Associated Switching Devices, Naval Shipboard
MIL-E-6051D	Electromagnetic Compatibility Requirements, Systems
MIL-S-8805D	Switch and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for
MIL-S-16032L	Switches and Detectors, Shipboard Alarm Systems
MIL-E-16400G	Electronics, Interior Communications and Navigation Equipment, Naval Ships and Shore, General Specification For
MIL-P-24212B	Pressure Transducer Equipment, Electrical
MIL-T-24387A	Temperature Measurement Equipment Signal Conditioning and Power Supply (Electrical) (Naval Shipboard)
MIL-T-24388B	Thermocouple or Resistance Temperature Element Assemblies, General Specifications for (Naval)
MIL-L-23886A	Liquid Level Indicating Equipment (Electrical) (Naval Shipboard Use)
MIL-F-24259	Fluid Flowmeter, Volume Velocity Type
MIL-F-24291B	Flowmeter, Fluid Electromagnetic Type
MIL-D-24304A	Differential Pressure Transducer Equipment (Electrical)(Naval Shipboard Use)

2.2 MILITARY STANDARDS

DOD-STD-100C	Engineering Drawing Practices

DOD-STD-480A	Configuration Control - Engineering Changes, Deviations and Waivers
MIL-STD-470A	Maintainability Program Requirements (For Systems and Equipment)
MIL-STD-785B	Reliability Program for Systems and Equipment Development and Production
MIL-STD-490A	Specifications Practices
MIL-STD-881	Work Breakdown Structures for Defense Material Items
MIL-STD-961A	Military Specifications and Related Documents, Preparation of
MIL-STD-1521A	Technical Reviews and Audits for Systems, Equipments, and Computer Programs

3.0 REQUIREMENTS

The objective of this effort is to design, fabricate, test and install a fiber optic engineering sensor system containing the fiber optic sensors, optical telemetry, and system interfaces that will correct known deficiencies in currently installed engineering (damage control, system control, i.e., propulsion or steering, or intrusion defense) sensor systems. The effort shall be accomplished in four phases. Phase I shall develop a conceptual design of an engineering sensor system. One or more contractors may be involved in this process. In Phase II, a laboratory demonstration model (LDM) shall be designed, built, and tested. Phase III shall develop an advanced development model (ADM) to the system specification developed in Phase II. The ADM shall be tested in an operational type environment. An engineering development model (EDM) shall be built in Phase IV and tested onboard a naval platform. The Government retains the option to proceed or not to proceed with Phases II through IV as

circumstances dictate. The Contractor shall develop a program management plan that adheres to the phased schedule shown on page 10 of this SOW.

The Contractor shall conduct technical design reviews during each phase of the program. These design reviews will be used by the Government to assess the progress of the program and to determine whether to proceed to the next phase of the program. The technical design reviews shall be conducted in accordance with MIL-STD-1521A.

3.1 PHASE I - CONCEPT DESIGN

The Contractor shall develop a concept design of an engineering sensor system in accordance with the specifications in Section C for Contract Line Item Numbers (CLIN) 0001AA and 0001AB.

3.1.1 Technical Objectives. The concept design effort shall include:

a. Studies of an existing engineering sensor system (sensors, telemetry, and display and control equipment) to evaluate performance, reliability, maintainability, and cost effectiveness and to document known deficiencies.

b. A conceptual design of a fiber optic engineering sensor system that will correct the deficiencies identified in the concept study. Section 2.1 provides a listing of military specifications that may be used for guidance in developing system design requirements.

c. An analysis of the trade-offs between the new design concept and existing design to determine the potential for cost reduction, standardization. manufacturability, and improved performance.

3.1.2 Program Management Plan. The Contractor shall prepare a basic program management plan. The plan shall provide detailed procedures for Phase I and outline the management philosophy for Phases II through IV.

3.1.3 Reviews and Reports. The Contractor shall prepare program review documentation and conduct a System Design Review (SDR) to report the results of Phase I and to recommend one or more conceptual designs that can be implemented within the program timeframe.

The Government will assess the effectiveness and viability of the proposed design approaches. Based on the results of the SDR, the Government will approve

the concept design and determine whether to proceed or not to proceed with Phase II, the Laboratory Demonstration.

Progress and cost reports shall be submitted monthly.

3.2 PHASE II - LABORATORY DEMONSTRATION (OPTION 1)

The Contractor shall develop a laboratory demonstration model of a fiber optic engineering sensor system and other associated components in accordance with the specifications in Section C for CLIN 0002AA and 0002AB. The laboratory demonstration model shall be an implementation of the design approved at the System Design Review.

3.2.1 Technical Objectives. The laboratory demonstration model effort shall include:

a. Design, development, fabrication, test, demonstration, and delivery of a fiber optic engineering sensor system laboratory demonstration model. For the purpose of this demonstration, the engineering sensor system model shall consist of:

1. One or more fiber optic engineering sensors.
2. A fiber optic telemetry link.
3. A system interface device that will interface the fiber optic engineering sensors with the selected control and display system.
4. Electrical and optical interfaces for input power, output signals, and control circuitry.

b. Development of a System Specification in accordance with MIL-STD-490A (Type A). This specification will provide the functional baseline for the Advanced Development Model to be developed in Phase III.

c. Preparation of Level 1 drawings in accordance with DOD-D-1000B for the functional baseline system.

d. The Contractor shall prepare operating instructions for all the equipment delivered. The instructions shall be written for skilled technicians.

3.2.2 Program Management Plan. The Contractor shall update the management plan prepared in Phase I. This update shall include a system test plan for the fiber optic sensor system. A Level 3 Project Work Breakdown Structure (WBS), prepared in accordance with MIL-STD-881 shall be included in the management plan.

3.2.3 Reviews and Reports. The Contractor shall prepare program review documentation and conduct a Preliminary Design Review (PDR) to report the results of the Phase II. The Contractor shall demonstrate the Laboratory Demonstration Model at the PDR.

The Contractor shall notify the Government 15 days prior to the actual date of testing in order that a government representative(s) may, at the Government's option, be present at the test site and witness the tests.

The Government will assess the effectiveness and viability of the proposed design approaches. Based on the results of the PDR, the Government will approve the system design and specifications, establish the functional baseline, and determine whether to proceed or not to proceed with Phase III, the Advanced Development Model Phase.

Progress and cost reports shall be submitted monthly.

3.3 PHASE III - ADVANCED DEVELOPMENT MODEL (OPTION 2)

The Contractor shall develop an Advanced Development Model (ADM) of 4 different types of fiber optic sensors, in accordance with the statement of work and Section C Specifications for CLIN 0003AA and 0003AB. The ADM shall be based on design concepts developed in Phase I for reflective sensors which utilize two wave lengths for sensor operation and provide a continuous readout.

3.3.1 Technical Objectives

a. Design, development, fabrication, test, demonstration, and delivery of an ADM of each of the following types of fiber optic sensors--pressure, 0 to 100 psig; differential pressure, 0 to 100 psi; temperature, 0 to 400 ^{o}F; and linear displacement, 0-1 inch. Specification details are given in Section C of the contract schedule. Each ADM shall be a fully functional sensor built to best commercial standards, packaged for a potential Navy application, and consist of:

1. A transducer head that outputs an intensity modulated light signal according to the value of the signal being measured. (Pressure, temperature, etc.).

2. A fiber optic cable that couples light signals between the transducer head and the electrooptic module. The sensor must meet specification requirements with cables up to 100 meters long.

3. An electrooptic module that provides the light sources transmitted to the transducer head, detects the reflected signals and develops an analog voltage output. If a digital signal corresponding to the output is available, this shall also be provided as an output.

4. The necessary interfaces for input power, output signals and input signal.

b. Preparation of sensor specification for each type of sensor developed. The Type A requirements of MIL-STD-490A shall be used as a guide for specification content.

c. Preparation of commercial grade drawings for each type of sensor being developed. Level 1 of DOD-D-1000B shall be used as a guide for minimum content.

d. Testing of the ADM's in an environment that simulates the intended operational environment of the system. The contractor shall perform environmental and acceptance tests on each ADM in accordance with the NRL approved test plan and test procedures (see paragraph 3.3.3). Each ADM will be tested separately as soon as possible after it is fabricated and proven ready for acceptance testing. The contractor shall notify the Government 15 days prior to the actual date of testing in order that a Government representative(s) may, at the Governments option, be present at the test site and witness the tests. The contractor shall provide all facilities and equipment required to test the ADMs and demonstrate their performance to the Government. The contractor shall deliver to NRL three working models of each ADM which passed its acceptance tests.

3.3.2 Program Management Plan. The contractor shall update the program management plan. This revision shall include a separate milestone schedule for each sensor type. The plan shall provide for the performance of each sensor to be demonstrated at the first design review following completion of the fabrication and testing of that sensor. A contract work breakdown structure (CWBS), prepared by the contractor in accordance with NAVSEA 562C Fiber Optic Work Breakdown Structure, shall be included in the program management plan.

3.3.3 Sensor Test Plan and Test Procedures. The contractor shall prepare a test plan for the environmental and acceptance test to be performed in the ADMs. Separate test procedures for each type of ADM shall be prepared covering each test to be performed. Test plans and procedures are to be submitted to NRL for approval.

3.3.4 Sensor Operating and Maintenance Instructions. The contractor shall prepare commercial grade operating and maintenance instructions for each type of sensor developed.

3.3.5

3.3.6 Electromagnetic Compatibility Plan. The contractor shall develop a comprehensive plan to demonstrate that the sensors will perform their functions in the expected electromagnetic environment in which they will be required to operate on shipboard.

3.3.7 Reviews and Reports. The contractor shall prepare program review documentation and conduct design reviews every two months. The first program review shall be a Preliminary Design Review (PDR) to review the ADM design. The Government will assess the effectiveness and viability of the proposed design approaches. Based on the results the PDR, the Government will approve the ADM design. The functional baseline will be established at this time.

The contractor shall prepare a program review documentation and conduct a Critical Design Review (CDR) after the factory acceptance test to report the results of Phase III. The contractor shall demonstrate the ADM at the CDR. During the CDR for each ADM, the capability of the sensor design to be modified for use within operating ranges required for shipboard operation other than the range specified for the ADM shall be demonstrated. An estimate of cost and lead time required to delivery 25 additional units of each approved ADM shall be included in the design review data.

Progress and cost reports shall be submitted monthly.

3.4 PHASE IV - ENGINEERING DEVELOPMENT MODEL (OPTION 3)

The Contractor shall develop an Engineering Development Model (EDM) of the fiber optic engineering sensor system in accordance with Section C Specifications for CLIN 0004AA and 0004AB. The EDM will be tested on a naval platform. The EDM shall conform to the functional baseline (CIDS) approved at the Phase II Critical Design Review.

3.4.1 Technical Objectives. The Engineering Development Model effort shall include:

a. Design, development, fabrication, test, demonstration, and delivery of an EDM of a fiber optic engineering sensor system. For the purposes of this demonstration, the EDM shall consist of:

1. Fiber optic engineering sensors packaged for a naval application.
2. An optical telemetry link using military qualified components to the maximum extent possible.
3. A system interface device that will interface the EDM with the shipboard equipment.
4. The necessary electrical and optical interfaces, packaged for use in the planned environment.

b. Development of a Critical Item Product Specification (CIPS)(Type C2) in accordance with MIL-STD-490A and MIL-STD-961A.

c. Development of Level 2 drawings.

d. Implementation of configuration management including product baseline documents, installation control drawings, and engineering documents in accordance with DOD-STD-480A.

e. Implementation of ILSP procedures including quality assurance, R&M, safety, development of technical publications, and training.

f. Installation of the EDM on a naval platform.

g. Testing of the EDM on the naval platform.

3.4.2 Program Management Plan. The Contractor shall update the program management plan. This revision shall include plans for ship checks, installation and checkout, and shipboard testing of the fiber optic engineering sensor system.

3.4.3 System Test Procedures. The contractor shall prepare test procedures for the EDM. These procedures shall include the shipboard test procedures.

3.4.4 Integrated Logistics Support Plan. The Contractor shall implement the Integrated Logistics Support Plan (ILSP) approved in Phase III including the:

a. Reliability and Maintainability Plan

b. Baseline Management Plan

3.4.5 Configuration Management. The Contractor shall implement the Configuration Management (CM) Plan developed in Phase III and conduct functional and physical configuration audits to verify that the EDM complies with the requirements of the CIPS and to establish the Level 2 drawing package as the product baseline.

3.4.6 Electromagnetic Compatibility (EMC) Plan. The Contractor shall update the EMC Plan to include the actual environment expected on the ship.

3.4.7 Reviews and Reports. The Contractor shall prepare program review documentation and conduct design reviews every two months throughout Phase IV.

The Contractor shall prepare a report reporting the results of the shipboard tests.

The Contractor shall prepare a final report describing the results of the program. This report shall include the system description, critical item product specification, Level 2 drawings, preliminary ILS documents, CM documents, technical manuals, and training documents.

Progress and cost reports shall be submitted monthly.

Appendix B

FOESS

WORK BREAKDOWN STRUCTURE

PHASE III

FOESS

WORK BREAKDOWN STRUCTURE

WBS #	DESCRIPTION	
1000	PROGRAM MANAGEMENT	
5000	PHASE III: ADVANCED DEVELOPMENT MODEL	
	17 June to 17 October 1987	
5100	DESIGN	
	5110	ADM E/O MODULE
	5120	ADM TRANSDUCER
	5130	ADM PRESSURE MODULE
	5140	ADM DIFFERENTIAL PRESSURE MODULE
	5150	ADM TEMPERATURE MODULE
	5160	ADM LINEAR DISPLACEMENT MODULE
5200	FABRICATION	
	5210	ADM E/O MODULE
	5220	ADM TRANSDUCER
	5230	ADM PRESSURE MODULE
	5240	ADM DIFFERENTIAL PRESSURE MODULE
	5250	ADM TEMPERATURE MODULE
	5260	ADM LINEAR DISPLACEMENT MODULE
5300	ENVIRONMENTAL TESTING	
	5310	ADM TRANSDUCER
	5320	ADM PRESSURE MODULE
	5330	ADM DIFFERENTIAL PRESSURE MODULE

5340 ADM TEMPERATURE MODULE

5350 ADM LINEAR DISPLACEMENT MODULE

5400 PROJECT ENGINEERING

5410 ADM E/O MODULE

5420 ADM TRANSDUCER

5430 ADM PRESSURE MODULE

5440 ADM DIFFERENTIAL PRESSURE MODULE

5450 ADM TEMPERATURE MODULE

5460 ADM LINEAR DISPLACEMENT MODULE

5470 TEST AND EVALUATION PLAN

5480 DRAWINGS PRODUCTION

5490 DESIGN REVIEW DATA PACKAGE

17 October to end of Phase III

5200 FABRICATION (Continued)

5270 MANUFACTURE AND DELIVERY

5271 3 ADM PRESSURE MODULES, EACH WITH TRANSDUCER

5272 3 ADM DIFFERENTIAL PRESSURE MODULES, EACH WITH TRANSDUCER

5273 3 ADM TEMPERATURE MODULES, EACH WITH TRANSDUCER

5274 3 ADM LINEAR DISPLACEMENT MODULES EACH WITH TRANSDUCER

6000 PHASE IV: ENGINEERING DEVELOPMENT MODEL

7000 TEST AND EVALUATION

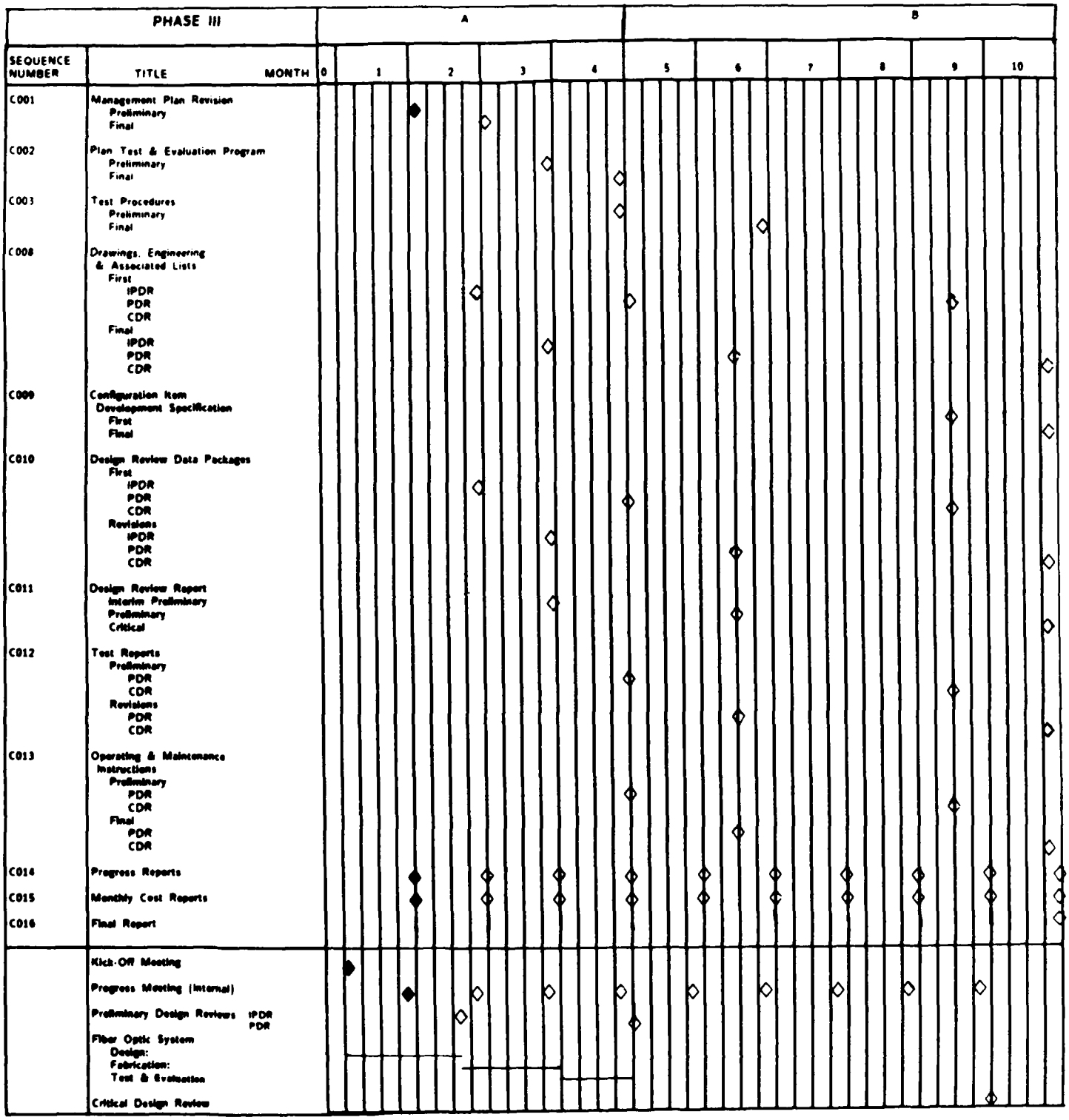
8000 SUPPORT

Appendix C

FOESS

PHASE III

MILESTONE SCHEDULE


PHASE III
A
B
SEQUENCE NUMBER
TITLE
MONTH
0
1
2
3
4
5
6
7
8
9
10
C001
Management Plan Revision
Preliminary
Final
C002
Plan Test & Evaluation Program
Preliminary
Final
C003
Test Procedures
Preliminary
Final
C008
Drawings, Engineering & Associated Lists
First
IPDR
PDR
CDR
Final
IPDR
PDR
CDR
C009
Configuration Item Development Specification
First
Final
C010
Design Review Data Packages
First
IPDR
PDR
CDR
Revisions
IPDR
PDR
CDR
C011
Design Review Report
Interim Preliminary
Preliminary
Critical
C012
Test Reports
Preliminary
PDR
CDR
Revisions
PDR
CDR
C013
Operating & Maintenance Instructions
Preliminary
PDR
CDR
Final
PDR
CDR
C014
Progress Reports
C015
Monthly Cost Reports
C016
Final Report
Kick-Off Meeting
Progress Meeting (Internal)
Preliminary Design Reviews
IPDR
PDR
Fiber Optic System
Design:
Fabrication:
Test & Evaluation
Critical Design Review

Appendix D

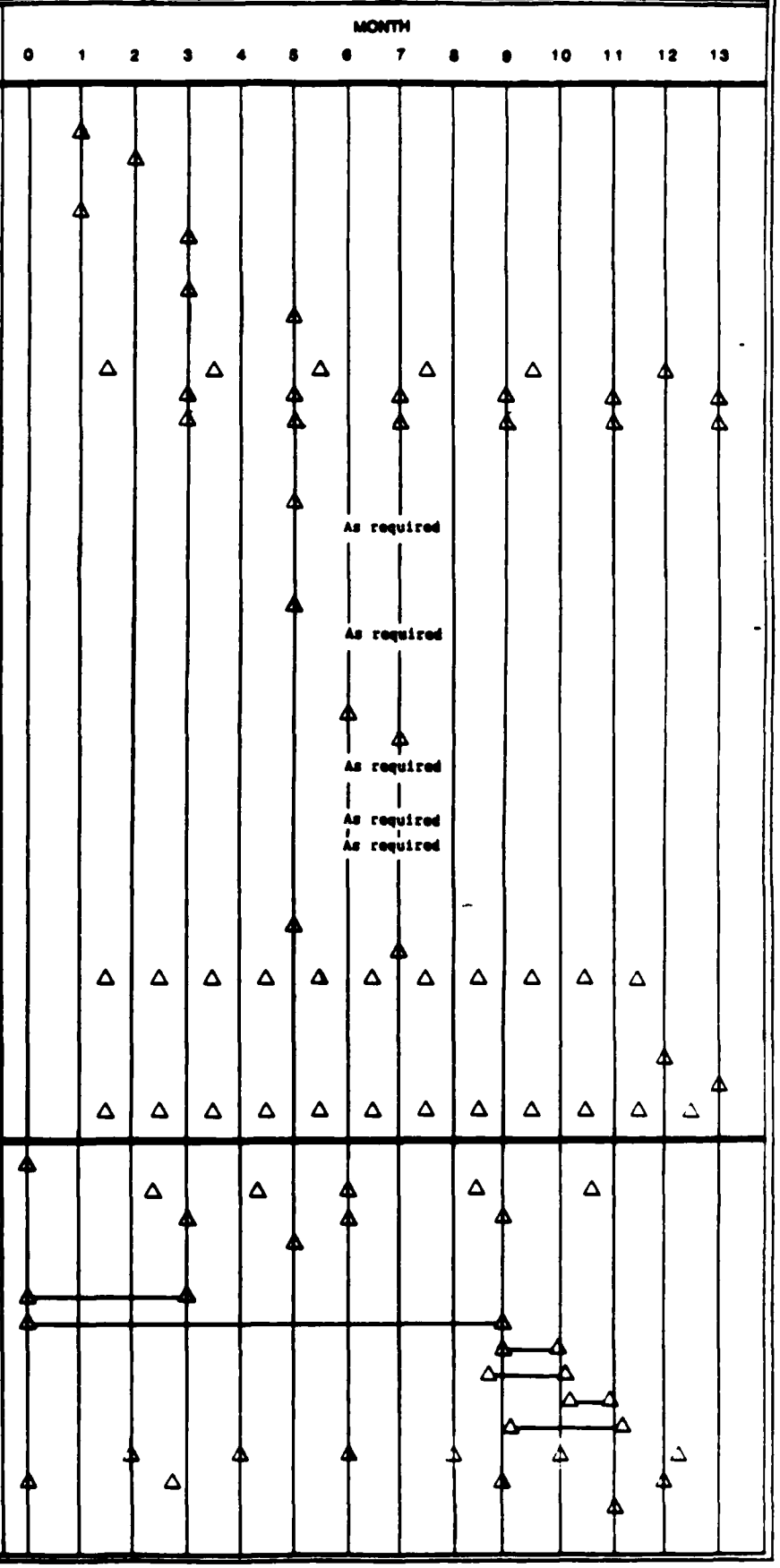
FOESS

PHASE - IV

MILESTONE SCHEDULES

PHASE IV

SEQUENCE NUMBER	TITLE
D001	Management Plan
	Preliminary:
	Final:
D002	Test & Evaluation Program Plan
	Preliminary:
	Final:
D003	Test Engineering Procedures
	Preliminary:
	Final:
D004	Design Review Data Packages
	First:
	Revision:
D005	Design Review Reports
D006	Configuration Item Product Function
	Preliminary:
	Final:
D007	Drawings, Engineering & Associated Lists (Level 2)
	Preliminary:
	Final:
D008	Drawings, Engineering & Associated Lists (ICD)
	Preliminary:
	Final:
D009	Test Reports
D010	Configuration Audits
	Agendas:
	Reports:
D011	Operating & Maintenance Instructions
	Preliminary:
	Final:
D012	Progress Reports
D013	Technical Report (Final Report)
	Preliminary:
	Final:
D014	Monthly Cost Reports
	Kick-Off Meeting
	Progress Meetings (Internal)
	Progress Meetings (NRL)
	Test Procedure (Final)
	Fiber Optic System
	Design Upgrade
	Fabricate
	Test
	Install
	Test Shipboard
	Shipboard Test (EST)
	Design Review
	Update Phase III Plans
	Sensor System



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